ENGINEERING OUTLOOK

AT THE UNIVERSITY OF ILLINOIS

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VOL. 2, No. 2, FEBRUARY 1961

COOL LIGHT BRIGHTER THAN THE SUN

Pure, cool and intense light from a ruby crystal about the same size and shape as a regular cigarette has been transmitted over a distance of 25 miles. This device is called a laser (light amplification by stimulated emission of radiation). Because the unique device can be used in present studies of light modulation at the University of Illinois, one is being constructed by a group under Professor D. F. Holshouser of the Department of Electrical Engineering.

The laser, originally suggested by researchers at Columbia University and first realized at Hughes Laboratories, produces light that differs from ordinary incandescent and fluorescent light. The laser's light is coherent: the emitted particles of light, photons, have waves which are synchronized with each other. This results in much greater intensity. The light emerging from the laser is confined to a very narrow beam, spreading so slightly that the beam can be detected at great distances. It has been estimated that a four inch lens used in conjunction with the laser could be used to beam a detectable light signal to the moon. In addition, the laser's coherent light is cool rather than hot. Unlike hot bodies, the laser's radiation may be confined to a very narrow spectrum of visible light. Although the laser's light is cool, it has been estimated that the sun would have to be a million times hotter than it is at present to match the laser's brightness at a given frequency.

Basically the operation of the laser involves exciting atoms to a higher energy level from which energy is reradiated in a narrow band of frequencies. Although a knowledge of the complex field of modern solid-state physics and familiarity with the quantum mechanics picture of matter and radiation are necessary to fully understand the laser's secrets, the device is simple in its physical structure. For example, a laser built at the Bell Telephone Laboratories consists of a synthetic ruby rod whose flat, highly polished ends are silvered and whose sides are left open to admit the exciting radiation. The ruby rod is held in the center of a spiral photoflash lamp that lights the ruby with an intense flash of ordinary white light. When the power applied to the photoflash lamp reaches a certain value a beam of red light is emitted through the ruby's silvered ends. It is the special nature of this emitted light that currently intrigues researchers.

Because its highly directional beam can be focused to pin-point sharpness, the laser shows great promise in space communication and navigation. Beamed to satellites and other space vehicles, it may become possible for laser signals to carry more information with less power than present radio signals. Current lasers, however, are limited for communications because they emit their light in short bursts rather than in smooth pulses. But this limitation may not be a shortcoming to other applications in the fields of atomic physics, astronomy, and medicine. The short bursts of light may possibly be modulated to carry much more information than is now possible. If modulation is achieved, it will be possible to have many telephone conversations or television signals transmitted simultaneously over a special kind of communication network — a "light" network!

The U. of I. laser will be used primarily to aid current studies of light modulation being sponsored by the Air Force Office of Scientific Research. Professor Holshouser indicates that when the ruby laser is completed it will be possible for his group to conduct further experiments aimed at increasing knowledge of the promising and rapidly expanding field of light.

AN INVITATION TO VISIT US

From electrons to concrete slabs, from farm tractors to space vehicles, the whole range of engineering education and research will be on display at the annual Engineering Open House, March 10-11. High school students and teachers, practicing engineers and scientists, and members of the general public are invited to attend.

Engineering students, with the help of the faculty, will put the entire College of Engineering on display. Members of Tau Beta Pi, engineering honorary fraternity, are organizing and directing the event.

High school students will find Open House a good opportunity to learn about the many fields of engineering.

Engineering students and faculty will be in the laboratories and at the displays to answer questions about courses of study and opportunities in engineering.

Some of the highlights of Open House this year will be displays in metal cutting techniques, plasma dynamics, and rocket propulsion systems, as well as visits to such major facilities as the nuclear reactor, the ILLIAC computer, the cyclotron, and the betatron. The 3,000,000 lb. tension and compression testing machine will, as every year, flex its muscles every hour on the hour.

Every possible effort will be made to answer our visitors' questions, show them a good time, and (hardest of all) help them find parking spots. For further information and guest parking permits, write to:

Engineering Open House Committee
114 Civil Engineering Hall
University of Illinois
Urbana, Illinois

CUTTING COSTS FOR CUTTING METALS

Today making chips in this country costs the machining industry 14 billion dollars a year, excluding "small chips" from grinding, honing, and lapping. Part of this high cost is caused by some of the super hard metals being cut, some of which would serve quite well as cutting tool stock with proper heat treatment. Tool wear for such machining is extremely high, which means low tool life and high production costs.

This figure, which is several billions higher than was predicted 2 years ago, suggests the national significance of metal cutting research programs like the one which has been in progress in the University's Mechanical Engineering Department for more than 15 years. Directed by Professors K. J. Trigger and B. T. Chao, this program has been directed toward finding the basic causes of tool wear. The role of temperature and tool-work compatibility has been clearly established.

Tool-chip interface studies have been made for a number of years. These studies have shown that in metal-machining operations there are two principal sources of heat generation: the shear zone and the tool-chip and tool-work interfaces. The shear zone is the region where major plastic deformation takes place, while both interfaces are sliding areas of contact where highly localized heating occurs.

After a tool has been in use, wear develops both at the tool-chip and the tool-work interfaces. The former manifests itself as crater wear and the latter as flank wear. Investigations at the University have indicated that both are fundamentally of the same nature. Wear may be of the ploughing type or of the diffusion type or both. Diffusion wear plays a major role in tool cratering at high cutting speeds. A portion of the hot chip adheres (welds) to the interface of the tool. Continued heat from the machining process maintains this condition until surrounding tool material is weakened. When another incoming chip removes the adhered material, a portion of the tool material is removed as well.

This dynamometer, designed and built at the University of Illinois, measures the vertical and horizontal components of the cutting force acting on the tip of the tool.

New metal removal processes such plasma-jet cutting and ultra-high speed machining (150,000 to 450,000 fpm) are being studied as possible solutions to such problems. Much work has been and is being done on finding better cutting tool materials and more efficient methods of cooling the cutting tools.

Temperature studies are but one phase of the attack on metal cutting problems. Modern day demands require not only harder and higher strength materials, but also cheaper and more efficient ways of machining them. It is this latter requirement that is the continual goal of the University's Metal Cutting Research Laboratory.

GRADUATE ENROLLMENT IS UP

Graduate enrollment in departments of the College of Engineering has increased nearly 17% in the past year. The totals, including graduate students in physics, are 1153 in the first semester of 1960-1961, as compared with 986 a year earlier.

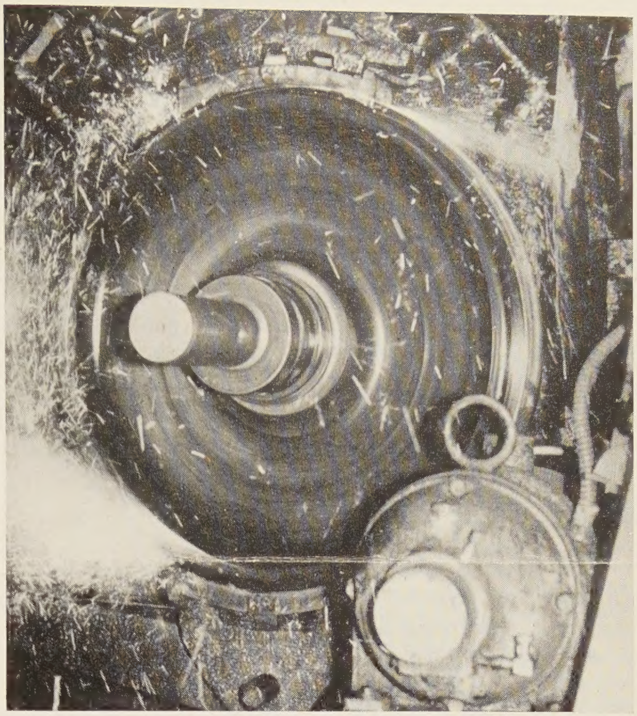
Quality, rather than quantity, is the primary requirement for the graduate training of engineers, but growth in numbers has some importance in determining quality. First, of course, it indicates that an increasing number of the nation's more promising young engineers are choosing the University of Illinois for advanced engineering training. In addition, a substantial number of graduate students makes possible the development of a diversified graduate faculty and a broad research program. These in turn assure strong graduate educational curricula. The physical needs for well-equipped laboratories and library collections can be met more readily and economically with substantial numbers of graduate students making use of them.

Specific comparisons of trends in individual departments are shown in the table below.

NEARLY 2 BILLION MILES A DAY

While it is often said that this is the age of the superhighway, it might better be called the age of the street. Americans are traveling *650 billion miles a year* in their automobiles, and 60% of this travel is urban movement. In fact, the movement on superhighways going through or close to cities is 75-80% local traffic! This situation, partly the cause and partly the effect of the buildup of suburbs, suggests the impact of highways on urban life.

To understand this impact and the complex issues of coordinating highway and urban development was the purpose of the American Association of State Highway Officials (AASHO) Urban Planning Seminar at the University of Illinois January 29 through February 1. This was 1 of 4 such seminars which covered the 4 AASHO regions of the United States. The other 3 were held at the University of California, MIT, and the University of North Carolina.



This railroad wheel is undergoing a simulated emergency braking test in the U. of I. Railway Labs at an equivalent train speed of 115 m.p.h. Such tests have proved that, contrary to popular opinion, the coefficient of friction will *increase* with an increase in temperature at a given brake shoe pressure. In tests of sufficient duration, the heat indicated by the sparks will frequently weld the brake shoe to the wheel when the wheel stops rotating. Such tests date from 1898, when the University instituted its program of railway engineering.

The seminar was attended by chief administrators and top urban people of Region III, the Mississippi Valley states area. It was sponsored by the Division of University Extension, the Department of Civil Engineering, and the Department of City Planning and Landscape

GRADUATE COLLEGE ENROLLMENT

Fall Semester 1960-1961

DEPARTMENT	FIRST-YEAR GRADUATE STUDENTS	BEYOND FIRST YEAR	NON-DEGREE CANDIDATES	TOTAL
Aeronautical Engineering	15	15	...	30
Agricultural Engineering	13	...	1	14
Ceramic Engineering	6	9	...	15
Chemical Engineering	18	27	1	46
Civil Engineering	160	95	10	265
Electrical Engineering	146	109	2	257
Mechanical Engineering	88	47	1	136
Metallurgical Engineering	19	23	...	42
Mining Engineering	4	2	...	6
Nuclear Engineering	27	1**	...	28
Theoretical and Applied Mechanics	32	43	...	75
NET TOTALS	528	371	15	914
PHYSICS*	126	110	3	239
TOTAL INCLUDING PHYSICS	654	481	18	1153

* No graduate degree in Engineering Physics.

** Included as M.S. in Civil Engineering also.

Architecture. These groups were represented, respectively, by Mr. Norman W. Johnson, Professor Ellis Danner, and Professor William I. Goodman, the Seminar Coordinator. Professor Danner is the Director of the Illinois Cooperative Highway Research Program and is in charge of highway engineering at the University.

The basic problem facing the seminar attendees was how to route highways in relation to city locations for the greatest possible safety, convenience, and economy. Routing them away from or around cities is not the answer because the proportion of through, cross-country travel is slight compared to town-to-town or suburb-to-business district traffic flows. Routing them through the cities is not a perfect solution either, because slower local traffic flow may congest the throughways and cause dangerous situations for fast-moving through traffic.

Problems like these show the great importance of highway design to the social, psychological, political, and economic aspects of urban life. The far-reaching effects of this seminar, as well as the other 3, are hard to imagine; but at 650 billion travel miles a year, they are significant first steps in the direction city planners and highway engineers are going to move in the future.

THE PLAIN CONCRETE FACTS

Two thousand years ago, Roman engineers using plain concrete to build aqueducts were practicing the *art* of engineering, and they were good artists. But they understood very little of what was actually happening in the concrete or what the material's range of capabilities might be. What they knew was learned by long, costly, trial and error experience. Two thousand years ago there was time for this knowledge to accumulate through generations.

Today engineers are in a bigger hurry to know, and the range of their problems extends far beyond aqueducts. Today the engineer seeks to understand his materials and their capabilities so that he may safely predict their behavior in new and unusual applications.

The key to predicting the behavior of concrete under various environments and loadings is an understanding of the basic structure and properties of the cement gel. This understanding has been developed only in the past 10 years. Proper coordination of the information now available can lead to some anticipation of the progress in the effective utilization of concrete. This is the goal of the Second Conference on Fundamental Research in Plain Concrete, to be held September 5-8, 1961.

The Conference will be held at the University of Illinois conference center at Allerton Park, near Monticello, Illinois. A variety of topics will be discussed, including kinetics of hydration, rheology of concrete, origin and nature of strength, fracture, and aggregate reactions. As this list of topics indicates, it will be a conference for specialists in the concrete field.

The organization of this Conference was stimulated by the success of the first Conference, held in September of 1958. Organizations sponsoring this Conference are the American Concrete Institute, the American Society of Civil Engineers, the American Society for Testing Materials, the Portland Cement Association, the Reinforced Concrete Research Council, and the University of Illinois. Financial support for the Conference is being provided by the National Science Foundation.

Further information concerning the Conference is available from Professor Clyde E. Kesler, Department of Theoretical and Applied Mechanics, University of Illinois, Urbana, Illinois.

UNIVERSITY OF ILLINOIS BULLETIN
Volume 58, Number 44; February, 1961. Published seven times each month by the University of Illinois. Entered as second-class matter December 11, 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Office of Publication, 49 Administration Building (West), Urbana, Illinois.

VOL. 2, NO. 2, FEBRUARY 1961

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